VISIBLE COLOR AND PHOTOMETRY OF BRIGHT MATERIALS ON VESTA. S.E. Schroder[1], J.-Y. Li[2], D.W. Mittlefehldt[3], C.M. Pieters[4], M.C. De Sanctis[5], H. Hiesinger[6], D.T. Blewett[7], C.T. Russell[8], C.A. Raymond[9], H.U. Keller[10]. [1]Max-Planck-Institut für Sonnensystemforschung, 37191 Katlenburg-Lindau, Germany, schroder@mps.mpg.de, [2]Department of Astronomy, University of Maryland, College Park, MD 20742, USA, [3]Astromaterials Research Office, NASA Johnson Space Center, Houston, TX, USA, [4]Department of Geological Sciences, Brown University, Providence, RI 02912, USA, [5] INAF, Istituto di Astrofisica Spaziale e Planetologia Spaziali, Area di Ricerca di Tor Vergata, Roma, Italy, [6]Institut für Planetologie, Westfälische Wilhelms-Universität Münster, Germany, [7]Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, USA, [8]Institute of Geophysics and Planetary Physics, Department of Earth and Space Sciences, University of California, Los Angeles, CA 90095, USA, [9]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA, [10]Institut für Geophysik und extraterrestrische Physik, Mendelssohnstr. 3, 38106 Braunschweig, Germany.

Introduction: The Dawn Framing Camera (FC) collected images of the surface of Vesta at a pixel scale of ~70 m in the High Altitude Mapping Orbit (HAMO) phase through its clear and seven color filters spanning from 430 nm to 980 nm. The surface of Vesta displays a large diversity in its brightness and colors, evidently related to the diverse geology [1] and mineralogy [2]. Here we report a detailed investigation of the visible colors and photometric properties of the apparently bright materials on Vesta in order to study their origin. The global distribution and the spectroscopy of bright materials are discussed in companion papers [3, 4], and the synthesis results about the origin of Vestan bright materials are reported in [5].

Visible Colors: We investigated the colors of major types of bright material through the pseudo-color composites generated from HAMO images. We adopted the color scheme similar to that used by the Clementine mission to study the mineralogy of the Moon, where red represents the 750/430 nm ratio, green 750/980 nm, and blue 430/750 nm [6]. In this color combination, green is a proxy of the 1-µm band depth of pyroxenes, while red and blue are associated with slopes of the continuum. Fig. 1 shows the color composites of several areas associated with typical types of bright materials found on Vesta. Please refer to [3] for the definition of various types of bright areas.

Fig. 1a shows a crater near the Rheasilvia basin at about (64º S, 0º). It is different from other craters in that is appears to have no obvious ejecta at all. Most bright crater wall material (type 1) and slope material (type 4) associated with this crater show greenish color, suggesting deeper 1-µm pyroxene absorption. Whereas the brightest streak on the crater wall (circled in Fig. 1a) displays bluer color than the surrounding area, indicating shallower band depth. The reason for this difference is still under investigation.

There are several bright spots of material type 3 shown in Fig. 1a. They have similar colors as types 1 and 4 bright areas. However at HAMO resolution, we

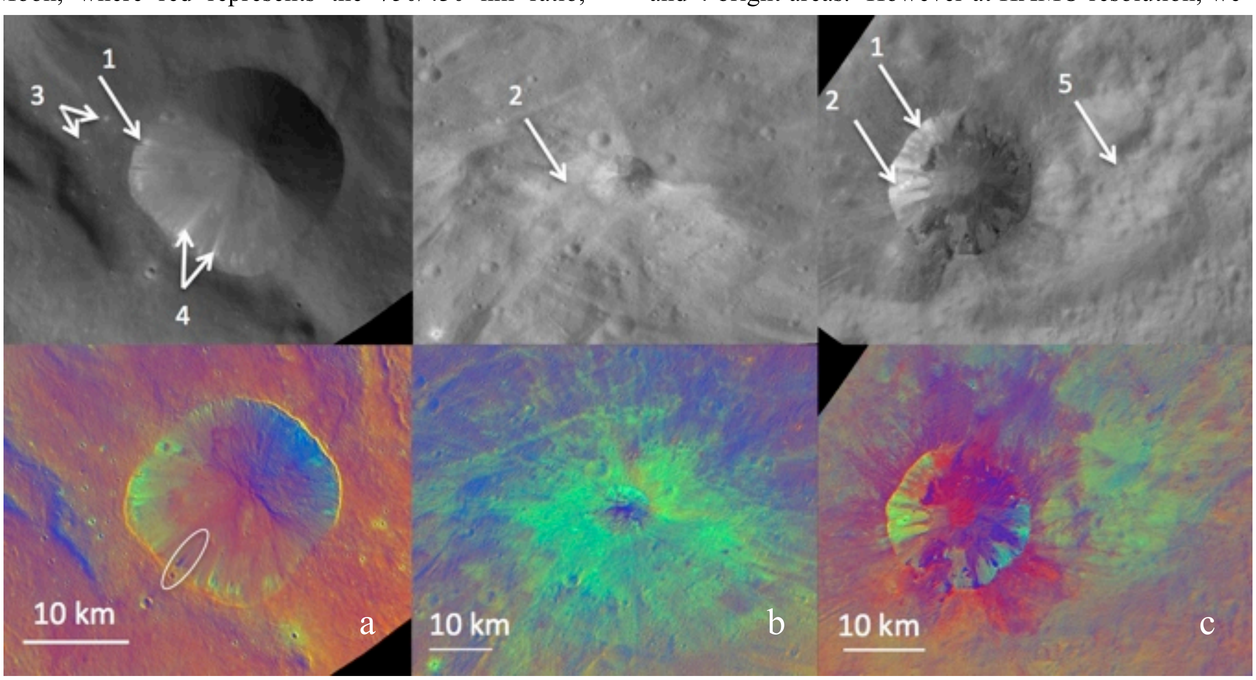

Fig. 1. The images of some major types of bright materials on Vesta through clear filter (upper row), and the corresponding Clementine color composites (bottom row). The arrows with numbers mark the types of bright materials and their locations [3].

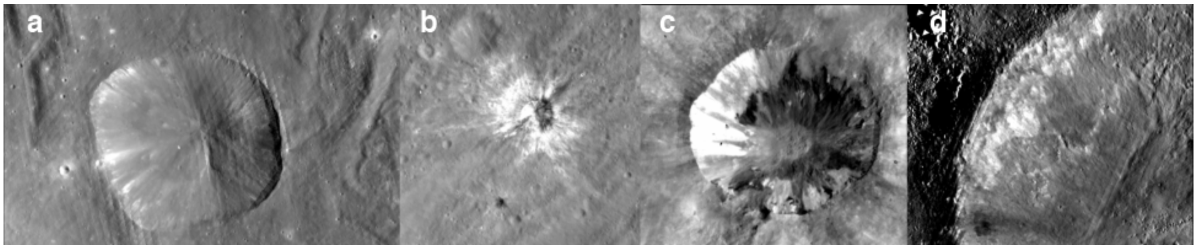

Fig. 2. The photometrically corrected images of some major types of bright materials on Vesta, showing the reflectance of these bright areas. These images were taken through clear filter during HAMO.

cannot see detailed color and brightness inside the bright spots.

The radial material of type 2 shown in Fig. 1b is near (34.6º S, 317.6º). The bright radial material, which is most likely the ejecta associated with the crater, appears to be greenish. However, the northeast section of the ejecta does not appear to be as bright, and shows slightly different color. The difference of brightness and color in different sections of the ejecta are also reported in their near-infrared spectra [4].

The patchy material (type 5) shown in Fig. 1c is near a crater at (9.0º S, 224.8º). It also displays greenish color than the surrounding area. However it appears to be disconnected from the area that appears to be the ejecta blanket. It is not clear how this area is associated with the formation of the crater. The bright crater wall material and slope material associated with this crater again show greenish color, similar to those types found in other locations.

Photometry: The photometric analysis of bright materials is based on FC images collected during Survey orbit through clear filter, which has an effective wavelength ~700 nm. The bidirectional reflectance of 10 selected areas associated with all major types of large-scale bright materials (Fig. 2) are measured from images taken at various times. The corresponding illumination and viewing geometries are calculated from Vesta shape model developed from Survey images [7]. Typically there are about 100-300 bidirectional reflectance data points with the associated observing geometries extracted for each bright area. The range of phase angle is from ~10º to ~90º. Because the field of view of FC at Survey Orbit is about half of Vesta's disk, the coverage in incidence angle and emission angle is typically from 10º to almost 90º. Therefore the best-fit photometric model is usually reliable with root-mean-square scatter of about 10-20%. The accuracy of spacecraft trajectory data and shape model is the dominant source of uncertainty in most cases

Hapke's modeling to these selected areas returns albedos of the bright areas about 20% or higher than Vesta's average geometric albedo of ~0.38 [8, 9]. The relatively high albedo suggests that bright areas are not due to topography. The modeled phase functions of all bright areas have parameters similar to the phase function of average Vesta surface, probably suggesting that the regolith particles in bright areas have similar shapes and internal structures with surrounding areas [10]. The Hapke photometric roughness of bright areas is all about 30º (with an estimated uncertainty of probably up to 10º), higher than the average roughness of Vesta about 20º [8]. Whether this difference is real or due to the limited observing geometry for the bright areas we modeled remains to be investigated. If this is real, then it could suggest larger particles in bright materials than surrounding areas. However, the physical interpretation of Hapke's roughness is still to be determined (e.g.,[11]).

Given the similar photometric phase function and roughness parameter of bright areas compare to average Vesta surface, we applied a photometric correction to all Survey and HAMO data to generate reflectance maps at the standard incidence angle 30º, emission angle 0º, and phase angle 30º. The reflectance maps for some areas derived from HAMO images are shown in Fig. 2. Typically, the bright crater wall and slope material is ~40% brighter than surrounding area; the bright radial material is ~30-40% brighter; the bright spots are about 20-25% brighter; and the linear and patchy materials are about 20% brighter. For some extremely bright areas, such as the slope material on the wall of a crater near the edge of the Rheasilvia basin (Fig. 2a), the geometric albedo is ~0.67. This is nearly 80% brighter than Vesta's average albedo.

References: [1] Jaumann et al. (2012) *LPS XLIII,* this conference; [3] De Sanctis et al. (2012) *LPS XLIII,* this conference; [4] Mittlefehldt et al. (2012) *LPS XLIII,* this conference; [5] Capaccioni et al. (2012) *LPS XLIII,* this conference; [6] Le Corre et al., (2012) *LPS XLIII,* this conference; [7] Preusker et al., (2012) LPS XLIII, this conference; [8] Tedesco et al. (2002) AJ 123, 1056; [9] Li et al. (2011) AGU Fall Meeting; [10] McGuire, A.F., and Hapke, B. (1995) Icarus 113, 134; [11] Shepard, M.K. and Helfenstein, P. (2007) JGR 112, E03001.